The Origin of the Scale of Fahrenheit's Thermometer.

YOUR issue of February 13 contains, on p. 348, a note on the above subject, in which it is stated that Fahrenheit based his scale upon a scale previously adopted by Newton, Newton's scale having its zero at freezing point and the temperature of the human body marked as 12 degrees. Fahrenheit (says Sir Samuel Wilks) found Newton's divisions too large. He therefore divided them by two. Next he altered his zero to the temperature produced by a mixture of ice and salt. Later on he again divided each degree into four parts, giving the scale which is now in use. This explanation is substantially that which is given in the "Encyclopædia Britannica."

It is evident that the origin of the Fahrenheit scale is a matter of some speculation. A recent work, the "Evolution of the Thermometer," by Mr. H. C. Bolton (reviewed in NATURE of May 9, 1901), states that Fahrenheit's selection of a scale was unfortunate, and did not appear to have been based on anything.

It seems very unlikely that Fahrenheit, who was an accomplished man of science and experimenter, and whose thermometers were acknowledged to be a great advance on others existing at the time, should have based his scale on nothing at all.

An examination of the main features of Fahrenheit's work upon thermometers gives, I think, the key to the origin of the scale, and shows that he based it upon a very sound and scientific foundation. In discussing this question, one must have a regard for the state of the knowledge of kindred matters at the beginning of the eighteenth century, and consider how the problem would be likely to present itself to Fahrenheit.

Reference is made in the note to a paper in the *Philosophical Transactions* for 1701, supposed to have been written by Newton. In this paper, which is written in Latin, is described a scale of degrees of temperature (Scala graduum Caloris) from the freezing point of water to the melting point of gold, but it does not appear that this scale was intended to be actually applied to a thermometer. It seems only to be intended as a convenient scale of reference for comparing temperatures covering a very wide range. The zero or starting point is the freezing point of water. The external temperature of the human body is taken as the second point from which the scale is derived. The range of temperature between these two points is divided into twelve parts. The freezing point is, therefore, called 0, and the body temperature 12. The scale is continued upwards, and it was found that the temperature of water boiling violently corresponded to 34 degrees. Many other degrees are noted as indicating the melting points of metals, &c.

The paper continues with a description of a thermometer, the liquid element of which is linseed oil. The actual scale of the thermometer, however, was not that described above, but was determined as follows:—

The thermometer was placed in melting snow. The space filled by the oil in the bulb and the stem together was taken as occupying 10,000 parts. The same oil, when expanded by the heat of the human body, occupied a space of 10,256 parts, and by the heat of boiling water 10,725 parts. Thus, on this thermometer, if the freezing point was marked 0, body temperature was 256 and boiling water 725. It was by means of this thermometer that the temperatures were obtained from which the "Scala graduum Caloris" was computed.

Fahrenheit is credited with having been the first to use mercury in the thermometer. He also discovered how to produce a temperature much below the freezing point of water by mixing "ice, water and sal-ammoniac or salt."

In a paper (also in Latin) which he contributed to the *Philosophical Transactions* of 1724, on the subject of "Experiments concerning the Freezing of Water," he described his thermometer, but did not explain his reasons for adopting the particular scale. It may be safely assumed that he was acquainted with the paper published in 1701 referred to above.

Having then decided upon the use of mercury in his thermometer in place of the oil previously used, the problem upon what basis his scale should be constructed would next arise. What could be more natural than to base it upon the expansion of mercury itself? The idea of making his degree or unit that difference of temperature by which the liquid expands by one *ten-thousandth part of its volume* would naturally occur to him, for it had already been done in the case of the oil thermometer. That this is the basis of the Fahrenheit scale I think is proved by the fact that for each degree of the Fahrenheit scale mercury *does* expand by one ten-thousandth part of its volume.

Having, therefore, determined upon the size of his divisions or degrees, the next thing was to fix on a zero or starting point. What, again, could be more natural than to start with the greatest degree of cold which he knew how to produce, namely, the temperature of the ice and salt mixture? Having settled upon this, everything else follows, and we have the Fahrenheit scale as we know it to-day. The thermometer registers for freezing point 32°, blood heat 98½°, and boiling point 212°. In his own description of his thermometer, he states that the temperature of the body is 96°, but this slight error was probably due to the thermometer not being properly heated by that part of the body to which it was applied, and in any case does not affect this explanation, which, I think, suggests that the Fahrenheit scale is based upon scientific principles, and is not, as is often supposed, a scale without rhyme or reason.

GILBERT S. RAM.

The Inheritance of Mental Characters.

I QUITE agree with Prof. Cockerell that further discussion of this subject had better be postponed, if, indeed, it be not wholly unprofitable. But I may, perhaps, be permitted to make three remarks:—

(1) The coefficient of correlation is a measure of the degree of resemblance between brothers. We are told it may be due to "soul," heredity or environment. "Soul," I take it, can only contribute to likeness between brothers, if they have like "souls." If so, I suppose the likeness of "soul" is due to inheritance of "soul," and I do not see how this is going to be distinguished from other forms of heredity. I am not unaware of Dr. Wallace's views on spirit hierarchies. I considered them in my "Grammar of Science," and still hold them thoroughly illogical and unscientific.

(2) What I asked Prof. Cockerell to do was to explain why the intensity in inheritance of mental and physical qualities came out the *same*. He may have views why they ought to be different, but it remains for him to explain why soul + heredity + environment in one case = heredity + environment in the other.

(3) I believe the mental characters in man are far more persistent than Prof. Cockerell credits them with being. The relations between head-measurements and intelligence are almost identical whether we deduce them from young children or undergraduates, and there is no apparent change of correlation when we compare brothers at close and at more distant ages. It is perfectly possible to determine from our data the proportions of children at each age with given mental characters. Prof. Cockerell belongs to those critics who live in the region of "may-be." If he will collect observations on some 5000 to 6000 children as we have done, he may still come down from the region of "may-be" and be able to place fact against fact.

University College, London. KARL PEARSON.

The Colours of Wings in Butterflies.

YOUR correspondent in India, W. G. B. (NATURE, February 13, p. 344), has been examining a butterfly in some ways like the *Morpho Cypris* of South America, the difference being that the latter has the upper side brilliant and the lower side brown.

The Morpho can be placed so that the two wings on one side of the body are metallic blue, while the other two are black; with a slight turn the two sides reverse colours. This seems to be like the case of the Purple Emperor, in which all edges of the scales facing one way are blue, and other edges are brown. A ploughed field with furrows running east and west might after snow and sunshine appear white from the north and black from the south. In London it is easy to see the Morpho; instead of the furrows it is possible to take for illustration a common form of advertisement.

The Morpho, like the Indian specimen, presents shades of ultramarine, peacock-blue, and sea-green; also in transmitted light the scales are golden. In most cases of coloured surfaces we are not yet able to point out the action on the light waves. Prof. Tyndall showed how small particles in air or water might reflect blue waves and allow the larger red waves to curl round them and go forward; but this does not apply to a surface which reflects the larger waves. It can only be said that coloured surfaces are such as have the power at a minute depth of selecting some waves for reflection; in the case of gold leaf or some butterflies' wings, the remainder of the light may be seen, transmitted almost without any loss by absorption, as the thickness traversed is so

minute. It is familiar knowledge that the intensity and the polarisation of reflected and transmitted lights vary with the incidence; and it seems likely that in the Morpho the changing tints of blue may arise through a varying partition of the reflected and transmitted colours. While, then, diffraction does not usually affect the appearance of the wings, it is, however, interesting to a student in optics to use the scales for experiment. Let a few wings, light-coloured for preference, have the scales scraped off on to a piece of glass, and let these be covered with glass as in a lantern slide; when they are placed in strong sunlight, there is the appearance of so many minute sparkling diamonds.

Since I wrote before, I have felt that in humming-birds also the colour is seldom due to diffraction. In one which I have before me, the head is red or black, the breast is golden or olive-green; the details of the feathers have two colours, one on each edge. They are strong mixed colours, not like spectrum colours of any order. In the Gould collection at South Kensington I was, however, able to find two birds—*Rhodopis vesper* and *Calypte annae*—in which the pigment colours were so subdued that diffraction lights were able to have some influence in the mixed effect. W. B. CROFT.

Winchester College, February 17.

Birds attacking Butterflies and Moths.

IN connection with the controversy on the above subject, I am permitted to add the testimony of an old friend of mine, Mr. H. S. Wise, of Ford, Drewsteignton, South Devon, an extremely keen and accurate observer, with wide experience both of British and Indian fauna. In letters to me dated February 9 and 12, 1902, he says:—"I have seen birds attack butterflies both in England and in India," and gives the following notes:—"On summer evenings, magpies hunt a grass field and catch immense numbers of moths, beetles and, I believe, butterflies. . . Last summer I shot a magpie, one of a family that was carefully working a large grass field; his beak was full of recently-caught Swift Moths (*Hepialus lupulinus*)." Later he says, "I have seen the common spotted flycatcher pursue a butterfly and miss it, giving up the pursuit; this was of course on the wing." Further, "titmice eat quantities of small moths, which they catch when at rest." Speaking of the large Yellow Underwing (*Tryphoena pronuba*), Mr. Wise tells me, "several small birds eat this moth, sparrows among the number; it is a strong moth, and the bird generally beats it on the ground to kill it before eating it. This insect is fond of lying on the ground among leaves, &c., and birds will hunt it out and catch it." Among other enemies of British Lepidoptera, Mr. Wise notes that "bats feed largely on the night-flying moths; *Tryphoena ianthina* is one I have seen them catch." My friend also refers to a note by G. C. Dudgeon, in the Journal of the Bombay Natural History Society for March 20, 1895, on the King Crow (*Dicrurus longicaudatus*) catching a butterfly (*Teinopalpus imperialis*, ♂), and adds, "In the case of a jungle-fire in an Indian forest, birds at once come and catch the numerous insects which fly up for safety, the above-mentioned King Crow being always to the fore." In India also lizards are formidable enemies to Lepidoptera. Mr. Wise says, "in Bombay there is hardly a lamp-post which has not got a gecko on it; these feed on the moths which are attracted to the light."

Mr. H. S. Wise, I am glad to say, promises to devote especial attention this summer to the question of birds attacking Lepidoptera, and to note, whenever possible, the name of the bird and the victim. If naturalists would more generally devote time to such work, we should soon accumulate sufficient direct evidence of the severity of the struggle for existence to place the matter beyond the possibility of dispute.

I regret to find that in my previous letter (p. 299) I unintentionally added a word to Mr. Latter's phrase, which should read "relinquished its hold in consequence of a luckily-aimed stick"—not "*only* relinquished," &c. The difference is not, however, essential, as the stick is stated to have been a cause of the bird's action. LILIAN J. VELEY.

20 Bradmore Road, Oxford, February 15.

ONE morning in 1901 (actual date not recorded) I found a Humming-bird Hawk (*Macroglossa stellatarum*) on a window in my house. I opened the window and tossed it out, thinking it would fly away, but it fell to the ground, where it remained quivering its wings within six feet of me.

A House Sparrow flew down from a Deodar, and with four dexterous pecks separated the wings from the thorax; it then pecked the middle of the thorax, splitting it, and with one or two more pecks separated the abdomen from the thorax. Taking the abdomen in its beak, the sparrow flew back to the tree from which it had come and, I presume, made a hearty breakfast.

The sparrow attacked the hawk in such a business-like way that it was obviously no new proceeding on its part.

There is always a martin's nest in my porch, and it is not uncommon to find wings and thorax of Agrotis, &c. on the seats or floor. JOHN HARTLEY DURRANT.

Merton Hall, Thetford.

The Severn Bore.

SINCE writing to you on February 12, I have had the opportunity of observing the bore of this morning, a tide which corresponds with that of February 12, 1899, which was remarkable. But to-day's "head" was a very poor one indeed, for no reason that I can find out; no wind and no fresh water in the river of any consequence. The only measure that I could make was of the wave at the shore, which at one point, and one point only, rose to 2¼ feet, whilst in midstream there was but little visible.

A distance of 520 yards having been measured out, and the time of passage having been taken by watches, I found that the speed was a fraction under 15 miles per hour.

The period occupied by the passage of the "head" from Newnham ferry was one hour; the mileage taken from the Ordnance map is a little over ten miles; average speed is, therefore, ten miles per hour.

This average cannot be far from correct, for I measured at Newnham, where the river is broad, and with wide sand-banks, which spread out on either side, up to Framilode, a distance of 5·2 river-miles, and here the banks begin to approach one another, and at five miles further up the stream is only 250 feet wide. E. W. PREVOST.

Newnham, February 24.

Beautiful Birds.

IN reviewing my child's book, "Beautiful Birds," F. E. B., writing in your columns, says, "Why should he select the 'beautiful birds' only, and, by implication, condone the massacre of birds that have not that advantage?" The question is a misstatement of fact, which I hope you will allow me to show, though I can only do so by quoting myself. On the last page—which I daresay F. E. B. did not get to—there is this: "'Mother, promise not to wear *any* feathers except the beautiful ostrich feathers that you look so *lovely* in?' As soon as she has promised, then all the beautiful birds in the world (and that means all the birds, for all birds are beautiful) will be saved," &c. (The italics are mine). This is the final promise and the goal to which I have been leading. May I ask F. E. B. whether, if he wished to arouse a child's interest and sympathies in any subject, he would choose the more or the less salient material to do it with?

19 Clarence Square, Cheltenham, Feb. 9. EDMUND SELOUS.

I ADMIT that I did not observe the phrase which Mr. Selous quotes from his book. But supposing that he can quote half-a-dozen such, I cannot allow that my observations to which he takes exception contain any injustice to him or real misstatement of fact. I would commend to Mr. Selous Dr. Samuel Johnson's sound remark concerning a quite analogous statement. An orchard, observed the Doctor, would be properly described as barren of fruit, even if subsequent research discovered a dozen apples and pears upon two or three trees. Now Mr. Selous' book is called "Beautiful Birds." It is not called "Birds." It is clear, too, what Mr. Selous means by "beautiful." His plates and the greater part of his descriptions deal with the Paradiseidæ, Humming Birds, and other birds which everyone calls beautiful. I do not find chapter after chapter relating to partridges, quails, sparrows, and other "plain" birds.

F. E. B.

King Og's Bed.

A HEBRAIST once told me that he thought that Og's iron bed, mentioned in Deuteronomy iii., 11, was a sarcophagus of basalt. The Hebrew word is "barzel," which is evidently the same as the Ethiopic "basal," iron, which Stormonth's dictionary gives as the derivation of "basalt." O. FISHER.

Harlton, Cambridge, February 20.